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## Vehicle rear vision system with electrochromic mirror

The present invention relates to a vehicle rear vision system according to the preamble of the main claim.

Vehicle rear vision systems are known which have at least one rearview mirror unit provided with an electrochromic mirror, a control device and a vehicle power supply device, the control device being connected for its power supply with the vehicle power supply device and with the electrochromic mirror in order to control the reflection properties of said mirror in dependence on a control voltage. Triggering of the electrochromic mirror in relation to its transmission or reflection properties comes about through a d.c. voltage which may be adjusted in level according to light sensors. The triggering voltage varies here in a range between 0V and e.g. approximately 1.2V. The d.c. voltage is generated from the

control device whose essential components are generally located in the housing of the rearview mirror located in the interior of the vehicle (interior mirror), in dependence on the amount of glare. As a rule, both the interior mirror and rearview mirrors located on the exterior of the vehicle (exterior mirrors) are provided with electrochromic mirrors; generally the low control voltage is used for the uniform actuation of the interior mirror and of the exterior mirrors.

However, problems arise from the fact that the vehicle voltage of standard passenger vehicles is generally between 9V and 16V (nominal 12V), whilst the highest value of the variable control voltage is e.g. only 1.2V. The consequence of this is that, with a typical current through an electrochromic mirror of approximately 300mA, dissipation of approximately 4W has to be converted into heat. on devices according to the state of the art, this transformation generally happens by means of a power transistor which is accommodated in the very low volume housing of the interior mirror. In order to cool down the very high temperatures occurring, aluminium cooling plates which have to be attached to the power transistor are generally used.

This unavoidable dissipation proves to be particularly problematic in the miniaturisation of the electronics. According to the present state of the art it is perfectly possible to integrate the entire electronics for actuating an electrochromic mirror in an integrated power semiconductor component (power IC). A power IC of this kind would however have to be able to lead away the above-mentioned 4W dissipation to the environment in such a way that its inner chip

temperature remains below a critical value of generally 125°C. This in turn requires, as well as a suitable costly power housing of the power IC, a sufficiently large volume of surrounding air which has a temperature low enough to cool. A large space of this sort is however not generally available in the interior mirror housing (moreover this large space requirement works against the intended miniaturisation). on exterior mirrors, this problem is further intensified; as well as there being generally an even smaller space available, here also the increased basic temperature of the mirror housing (for instance as a result of intensive sunshine in the summer) has to be taken into consideration.

Thus the purpose underlying the present invention is to create a vehicle rear vision system which makes possible the accommodation of the control device in the smallest space, without the dissipation which occurs leading to an impairment in the functioning of the control electronics system.

This purpose is fulfilled by a vehicle rear vision system with the features of the preamble of the main claim in connection with the characterising features of the main claim.

Through the fact that the control device has a sheet-type heating resistor to carry away the heat occurring through electrical dissipation, an impairment of the functioning of the control electronics can be prevented by an "evacuation" of the heat that occurs. Secondly it is possible to divert the heat occurring in the sheet-type heating resistor to a place where it fulfils for example the useful function of a heating device (for example for a mirror surface).

Advantageous embodiments of the present invention are given in the dependent claims.

An advantageous embodiment provides for the heating resistor to be applied as a coating to a carrier material, such as for example the non-reflective rear side of the mirror of the rearview mirror unit, a plastics foil or a flat electrical line ("flex" or strip conductor connection). The coating can be applied to a variety of flat carrier materials, the heat that occurs here does not impair the functioning of the control electronics and can also be used to advantage (for example to stop clouding over of the glass or icing of objects).

A particular advantageous embodiment provides for the heating resistor to be disposed in meander shape on the carrier material, preferably a plastics foil. On the same plastics foil there can moreover be disposed a meander-shaped mirror glass heating system produced in the same way, it being possible to dispose the meander structures of the two resistors compactly beside one another or interlocking with one another. In order to constantly guarantee a condensation-free mirror, this foil can be provided on both sides with double-sided adhesive tape and be glued on one side to the rear side of the mirror and on the other to a glass support plate. As well as very good heat conduction towards the mirror to be heated, this moreover makes possible low-cost attachment of the mirror glass to the glass support plate.

A further advantageous embodiment of the present invention provides for the control device to have a unit for pulse-width modulation of a control signal

with a signal level, preferably at the level of the vehicle voltage and the unit for the pulse-width modulation to be connected to a converter, belonging to the control device, for converting the pulse-width modulated signal into an analog control voltage. It is particularly advantageous when the signal level is at the level of the vehicle voltage, to convey a signal generated from a signal generation unit located in the housing of the interior mirror to the exterior mirrors. In this case, the converter according to the invention is located in the region of the exterior mirror; the dissipation occurring in said mirror during the conversion of the pulse-modulated signal at the level of the vehicle voltage into an analog control voltage of a lower level is converted again in a heating resistor according to the invention. In so doing, the separate earth wire between interior mirror and exterior mirrors, usual in rear vision systems according to the state of the art, and necessary in order to balance the potential differences between the interior and exterior mirrors of the vehicle. This stems from the fact that, when a voltage is supplied from the interior mirror to the exterior mirrors at the level of the vehicle voltage, the potential differences are of considerably less significance than with direct transmission of the low control voltage (e.g. a maximum of 1.2V).

Further advantageous embodiments of the present invention are given in the remaining dependent claims.

The present invention is now explained with the aid of several figures. These show:

Fig. 1 a heating resistor according to the invention on the rear side of an electrochromic mirror,

Fig. 2 a cross-section through an exterior mirror according to the invention,

Fig. 3 a block diagram of a vehicle rear vision system according to the invention,

Figs. 4a and 4b two possible ways of arranging the wiring of a heating resistor according to the invention.

Fig. 1 shows a dissipating resistor 3 according to the invention, which in the following is called heating resistor and which is embodied in meander shape and disposed on the non-reflective rear side 2a of an electrochromic mirror 2 of a rearview mirror unit. The application of the heating resistor to the rear side of the mirror 2a can come about by means of metal coating in a plasma process, screen printing using resistor paste (the resistor paste is applied in the form of the desired heating element) or galvanic coating. The heating resistor 3 (i.e. the coating) can be of copper, silver or aluminium. In each case, the heating resistor is configured in lines or flat; a heating resistor voltage is released between the electrical connections 3a and 3b which represent the beginning and end of the heating resistor.

Likewise, a mirror glass heating system 6 is attached to the rear side 2a of the electrochromic mirror 2, which system in addition heats the mirror 2. This can also be disposed in meander shape; it proves particularly advantageous if, as shown in Fig. 1, the course of the mirror glass heating system 6 is designed complementary to the course of the heating resistor 3.

It is not absolutely necessary to dispose the heating resistor 3 directly on the electrochromic mirror 2. There is admittedly an advantageous heating effect here which helps to prevent icing or clouding over of the mirror surface, but other arrangements are also possible. Thus, for example, provision can be made for the heating resistor 3 to be applied to foil printed circuits ("flex", or "FPC" supply lines). These supply lines can for example provide the electrical connection between the control device and the electrochromic mirror or also connect individual elements of the control device to one another (see in this connection also Fig. 3).

Fig. 2 shows the cross-section of an exterior mirror according to the invention or an exterior mirror unit 5. This has an electrochromic mirror 2 which is electrically connected, in a manner which is not shown in detail, with a control device. This control device or parts of the control device (see Fig. 3) can be accommodated within the housing 9 of the exterior mirror unit 5 (in Fig. 2 only the heating resistor 3 belonging to the control device and lying inside the housing 9 is shown).

The housing 9 is connected via a web 19 with the exterior chassis 18 of an automotive vehicle. A glass adjustment drive 8 situated inside the housing 9 carries a glass support plate 7. To the side of the glass support plate 7 remote from the glass adjustment drive 8 is attached a heating resistor 3 according to the invention. This is connected with further elements, not shown, of a control device via electrical contacts 3a, 3b, which can be embodied as flexible cables. The electrochromic mirror 2 is attached to the side of the heating resistor 3 remote from the

glass support plate. The attachment of the heating resistor 3 between the glass support plate 7 and the electrochromic mirror 2 can come about in various ways. The heating resistor 3 can for example be applied as a solid coating to the rear side 2a of the electrochromic mirror.

A further possibility is that the heating resistor 3 is embodied as a foil composite. To this end, the resistor element running between the contacts 3a and 3b is enclosed between two foils. It is now possible to attach this foil composite as a form-fit, for instance by means of a snap-on plug connection, to the rear side 2a of the electrochromic mirror. Another variant provides for the outer sides of the foil composite to be self-adhesive. In this case, the heating resistor 3 ensures the secure connection of the mirror 2 on the glass support plate 7 (instead of tile self-adhesive exterior surface of the foil, a double-sided adhesive tape can naturally also be glued to the outer sides of the foil composite, which has the same function).

It is also possible to accommodate further elements of the control device, e.g. an integrated circuit, between the glass support plate 7 and mirror 2. This integrated circuit can either be applied directly to the rear side 2a of the mirror 2 or to a foil. This application can come about in SMD technology or chip-on board technology. An integrated circuit could also be accommodated within the foil composite described above. Heat-resistant plastics are preferably used as foils here.

Further elements of the control device, for instance a digital-analog converter, can likewise be accommo-

dated inside the housing 9 of the exterior mirror unit 5, for example inside the glass adjustment drive 8.

The above embodiments referred by way of example to the exterior mirrors shown in Figs. 1 and 2. The described embodiments are similarly applicable to interior mirrors.

Fig. 3 shows the diagrammatic construction of the whole vehicle rear vision system. This contains two rearview units, an interior mirror unit 4 as well as an exterior mirror unit 5. A vehicle power supply device, not shown in detail, provides a d.c. voltage of a nominal 12V. The vehicle voltage can however be between 5V and 24V, depending on the automotive vehicle. The vehicle power supply device is connected to the control unit in order to supply it with power. The exterior mirror unit 5 has one or two electrochromic mirrors, (respectively one on each side of the vehicle), the interior mirror unit has one electrochromic vehicle mirror.

A glare sensor 10 attached to the interior mirror and orientated in the direction of reflection of the electrochromic mirror (i.e. towards the rear of the vehicle), measures the incident light flux from the rear of the vehicle (for instance from vehicles travelling behind same). A daylight sensor 11, which is orientated e.g. in the direction of motion or towards one side of the vehicle, determines a further light flux. Sensors 10 and 11 are connected to a computing unit 20 of the control device for data transmission. Depending on the measurement values of the sensors, the amount of glare is determined by the computing unit 20, and converted into an analog control signal.

This analog control signal is then supplied to a transistor (see input 17a of transistor Q in Figs. 4a and 4b). The circuit shown in Figs. 4a and 4b, which will be described in detail later, makes available to the electrochromic mirror 2 a d.c. voltage varying between 0V and 1.5V according to the amount of glare. In dependence on this voltage, the reflection properties of the electrochromic mirror 2 alter in known fashion. The analog voltage 21 is e.g. between 0V and 1.5V. It can however, according to the embodiment, cover higher voltage regions, e.g. from 0V - 2.5V.

In addition to controlling the reflection properties of the interior mirror, the computing unit 20 also controls the reflection properties of at least one electrochromic mirror 2 of the exterior mirror unit 5. To this end, the computing unit 20 transmits an analog signal, as was for instance supplied to the electrochromic mirror 2 of the interior mirror unit 4, to the electrochromic mirror 2 of the exterior mirror unit 5. This signal can be transmitted e.g. directly. Fig. 3 shows a further possible way of transmission.

This possibility consists in the analog control signal being digitised first of all in an analog-digital converter 15, which is accommodated for instance in a "roof module," of an automotive vehicle, (according to the design of the computing unit 20, in some embodiments a micro-controller integrated in the computing unit 20 can already emit a digital signal). The signal digitized in the analog-digital converter 15 is led by means of a data bus to a door control apparatus 12. The door control apparatus 12 is designed as a node, which controls all the functions of the door, such as glass adjustment drive, mirror

glass heating, tilting mechanism drive, lighting devices and signal device.

The connection between the door control apparatus 12 and unit 14 shows a further variant of the transmission of the control signal to an electrochromic mirror 2.

The door control apparatus 12 belonging to the control device contains a unit for the pulse-width modulation of a control signal with a signal level at the level of the vehicle voltage (naturally, as well as the standard 12V vehicle voltage, other levels of voltage are possible). The pulse-width modulated brightness signal is led with a signal level at the level of the vehicle voltage to unit 14. Unit 14 has a converter, belonging to the control device, for converting the pulse-width modulated signal 13 into an analog control voltage. In order to avoid the heat problems depicted in the introduction to the specification, in this conversion a circuit arrangement as per Figs. 4a or 4b is needed. The low analog control voltage (preferably between 0V and 1.5V) is then led to the electrochromic mirror 2.

In the present example, the computing unit 20 is accommodated in the interior mirror unit. it is naturally possible to accommodate the computing unit 20 in the exterior mirror unit 5 also. As a result of the design according to the invention of a heating resistor, no heat problems here occur in the exterior mirror, the heat can even be used as available heat for heating the mirror surface. The computing unit can also be accommodated in other places, for example in the region of the door control apparatus 12 or of the roof module.

The embodiment given by way of example and shown in Fig. 3 thus shows a plurality of transmission paths between the computing unit 20 and an electrochromic mirror 2:

1. analog transmission
2. digitization and transmission by means of data bus
3. pulse-width modulation with a signal level e.g. at the level of the vehicle voltage.

It is naturally possible to use just one of the systems presented for signal transmission. For this, in the case of digital transmission by means of data bus, (preferably a UART or CAN protocol is used) e.g. a digital-analog converter is necessary for converting the data bus signal into an analog control voltage.

Fig. 4a shows a circuit for minimisation of heat development in the region of the transistor Q. The sheet-type heating resistor 3 is connected in series to a parallel circuit of a control transistor Q and an electrochromic mirror 2. Between points 23 and 24 is released a voltage at the level of the vehicle voltage. Through input 17a, a control voltage or a control signal is supplied to the transistor Q, by which means the current passing through transistor and resistor is adjusted. Depending on this transient current, a different component voltage is released on the heating resistor R such that a residual voltage of a different level remains on the electrochromic mirror 2 and is for example in the region between 0V and 1.5V. The use of a circuit as per Fig. 4a is particularly advantageous since the dissipation occur-

ring in the transistor is particularly low therein, (instead of the 4W mentioned initially in power transistors according to the state of the art, here e.g. only 0.5W are to be converted in the transistor).

Fig. 4b shows a further embodiment of a circuit arrangement according to the invention. Between points 23 and 24 there is a voltage of e.g. 12V (the level of the vehicle voltage). In this embodiment, the transistor Q, which is actuated by a control signal 17a, the heating resistor 3 and the electrochromic mirror 2 are connected in series. As in the arrangement shown in Fig. 4a, the heating resistor is disposed flat (e.g. in a spiral or meander shape).

The circuits shown in Figs. 4a and 4b should be so laid out that the maximum control voltage on the electrochromic mirror is less than 25% of the nominal vehicle voltage.